MB89P568 Demo Board

User's Manual

Rev 1.0

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Revision History

Revision #	Date	Comments
1.0	07/12/2002	New Revision

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1 Introduction

1.1 Overview

This demo board shows the capabilities of the F2MC-8L series, popular MB89560 Microcontroller. It is intended for low cost, low power and small information message display purpose.

The MB89P568 Demo Board makes use of MB89P568PFV-101. It is an OTP device of MB89560 series having LCD controller/driver on chip.

1.2 Purpose

The main purpose of designing this demo board is to show the following applications:

1) Hardware interface of Microcontroller with alphanumeric segmented LCD panel
2) Software application for using on chip LCD controller/driver
3) Hardware and software applications using resources available on microcontroller like A/D converter, Watch pre-scalar, PPG and general purpose IO ports
4) Low power mode operation

1.3 Features

Following are the key application features of the demo board:

1) Six digit alphanumeric, 14 segment LCD display, with intensity adjustment.
2) Scrolling message display.
3) Display of Real time clock.
4) Alarm feature for clock.
5) Ambient temperature measurement and display in ºC.
6) Ambient relative humidity measurement and display in RH.
7) Calendar display- Day, Date, Month and Year can be displayed.
8) Hierarchical menu driven support for adjustment/display of the following parameters, using pushbutton switches provided on the board:
    a) Real time clock- Hour.
    b) Real time clock-Minute.
    c) Calendar day.
    d) Calendar date.
    e) Calendar months.

f) Calendar Year.

g) Alarm time.

h) Alarm stop.

i) Temperature display.

j) Humidity display.

9) For ease of use, supports both incrementing (+) and decrementing (-) parameter values, using pushbutton switches.

2.1.1 Board Specifications

- MB89P568 device with following features.

- F2MC-8L series OTP device mounted on the board

- By using foot print conversion adapter, the board can be used with In Circuit Emulator. Following adapter is preferred for converting from bottom 0.5mm 80 pin pitch to 0.80 mm 80 pin pitch.

  80QF-80QF2-8L-UP

  80QF-80SQF-8L-DWN

  (This adapter can be from http://www. advintcorp.com/)

- Device specifications:

  ROM – 48K x 8 bits

  Execution time: 0.4usec/ 10 MH

  GPIO – 30 pins

  10 bit x 8 ch ADC, 6 bit PPG, I2C, LCD driver on chip, UART, SIO

  Supports low power modes. Operates using min & sub clock

- Board operates using sub clock watch mode for low power operation.

1.4 Deliverables

- MB89P568 Demo board cases in acrylic package with Mounting base
- AAA Battery holder attached on rear side of the acrylic package
- Three AAA Batteries
- A buzzer diaphragm attached on back side of PCB for alarm beep
- Quick Start Guide
- CD ROM Containing

1. Hardware manual and data sheets of MB89560 series
2. MB89P568 User's Manual
3. Application note on " Choosing right LCDs for use with MCU having on chip LCDC"
4. Sample project files

2 Functional description

Figure 1: Functional Block Diagram of MB89P568 Demo Board

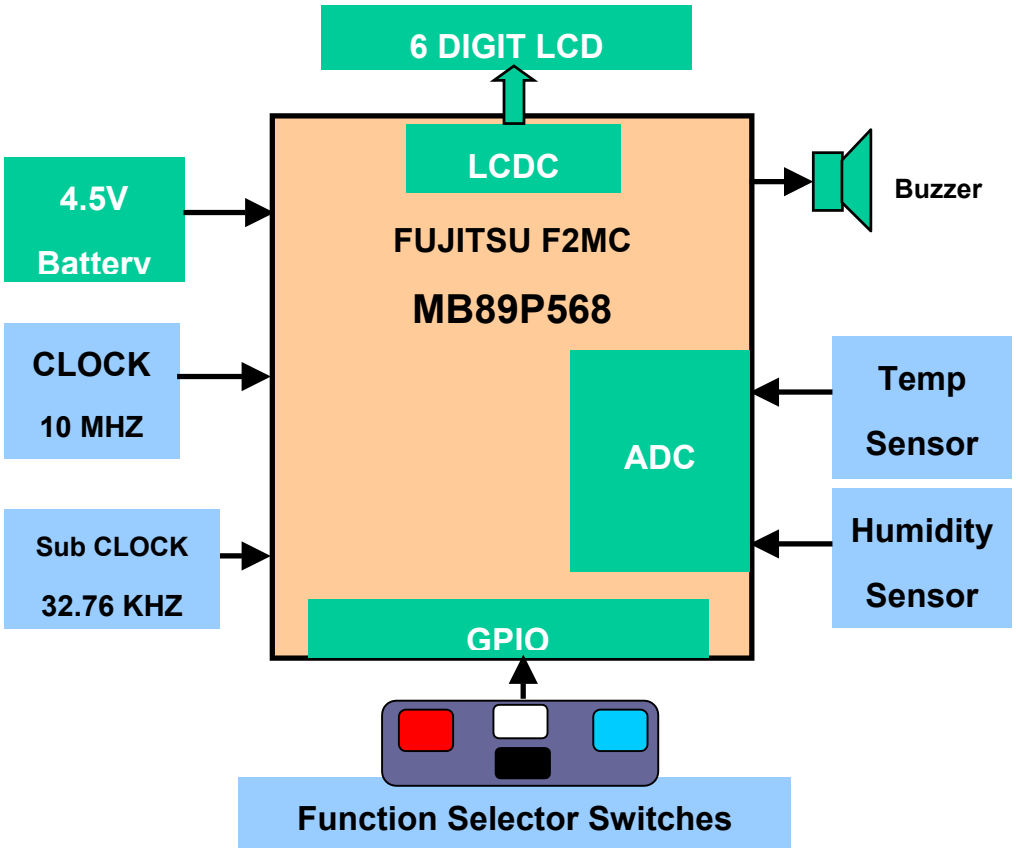


Figure 1 shows the functional block diagram of MB89P568 demo board.

2.1 Functions of Switches

Including 'RESET', there are five switches provided on the board. The function of each switch is explained in this section.

To enable user to initialize the board, select, adjust, input, control and display the parameters such as time, calendar, alarm, temperature, and humidity following five types of switches are provided on the board:

1. **RESET**: S1 (No color).

2. **Function Select**: S2 (Red color).

3. **Enter**: S3 (Blue color).

4. '**+**': S4 (White color).

5. '**--** ': S5 (Black color).

For ease of use, four main functional switches on the board S2 to S5 are color coded in 4 different colors, as described in the following sub-sections.

2.1.1 Reset Switch

Reset switch S1 is a simple (colorless) switch. It is provided near the microcontroller for 'RESET' operation. It also presets the parameter values to default initial values, for example the day, date and time is set to 'Tueday, January 1st, 2002, 12:00 AM respectively. User is expected to set day, date and time values according his requirement, using the four functional switches as described in this document.

2.1.2 Function Select Switch

It is a multi-function red pushbutton switch S2 , for selecting hierarchical functional menu that functions depending on the functions selected. **Figure 2: Menu Details** shows menu details and hierarchy. Following functions can be selected using this switch.

S2 'Function Select' switch when pressed, toggles between only two modes. The two modes are:

1) Display mode: DSP_MD

2) Adjust mode: ADJ_MD

To select any of the above modes press 'Function Select' Red switch. For the first time, 'Display mode' appears on LCD. When pressed the same for second time 'Adjust mode' appears on the display. For selecting one of the modes, press blue switch 'Enter'. If the parameter Display mode is selected, the Menu appears in sequence as shown below.

The function of this 'Display mode' is to view parameters like temperature, Humidity, calendar and alarm time whenever required according to user requirement.

When 'Adjust Mode' is selected by pressing blue switch 'Enter', the following parameter can be changed according to user requirement.

1) Hour value

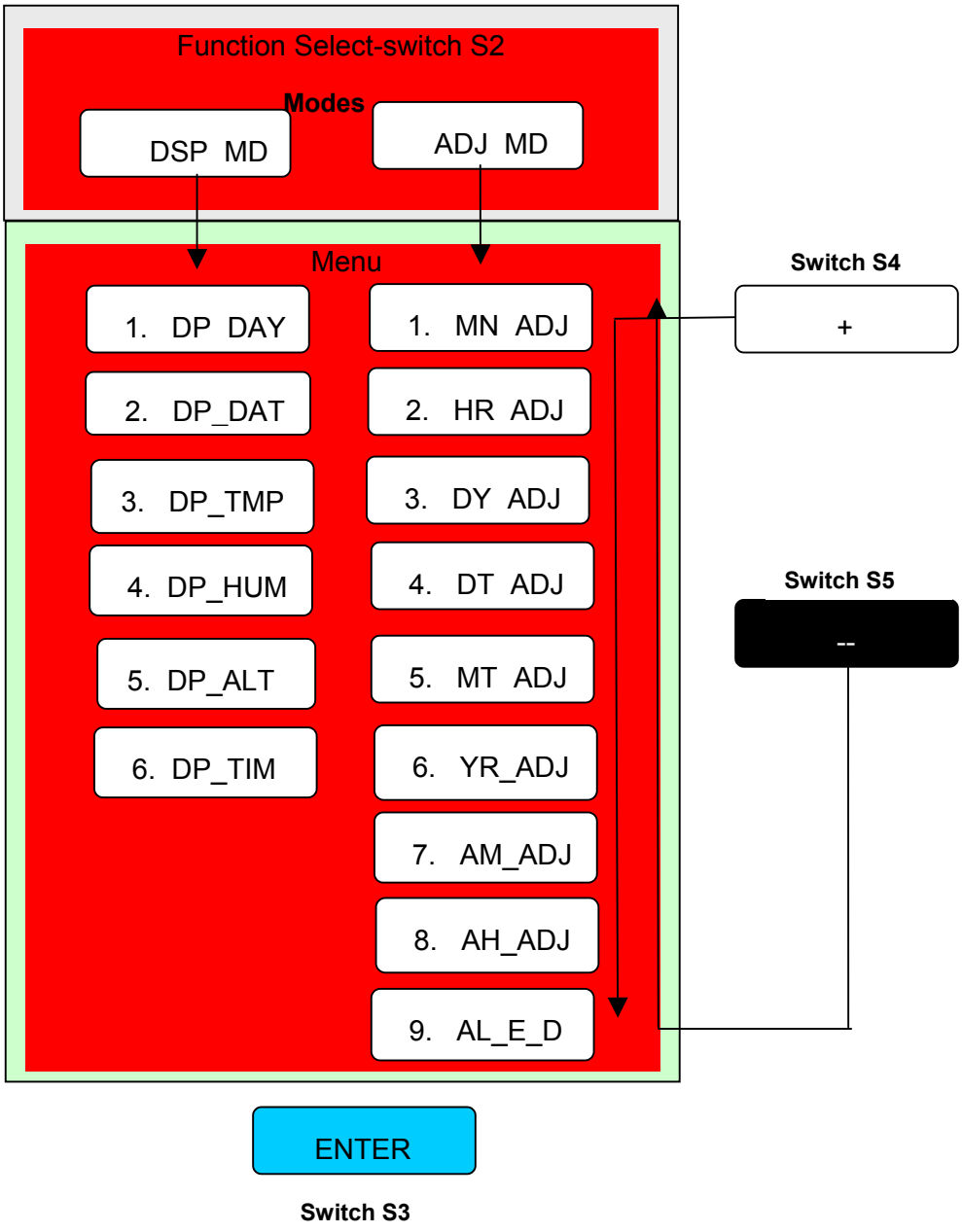
2) Minute Value

3) Alarm hour value

4) Alarm minute value

Refer to section 2.3 'Getting started' for the detailed procedure.

Figure 2: Menu Details



2.1.3 Enter switch

Enter switch dual function switch. It is used for two purposes.

- Pressing Blue pushbutton switch S3 is for accepting the selected functions of the menu.

- Pressing this switch stops alarm sound.

2.1.4 '+' or Increment switch

This White switch has two functions.

1) The switch is for selecting the menu options listed in above **Figure 1** in increasing sequence from 1 to 9.

2) The switch is also for incrementing the value of the selected parameter. For example, the switch is used to increment the hour, minute, date, month, year and day value.

2.1.5 '—' or Decrement switch

This black switch has two functions.

1) The switch is for selecting the menu options listed in above **Figure 1** in decreasing sequence from 9 to 1.

2) The switch is also for decrementing the value of the selected parameter. For example, the switch is used to decrement the hour, minute, date, month, year and day value.

2.2 Display Message Description

Following Table 1 describes Display messages. Since MCU is capable of interfacing 24 X 4 elements of LCD, it is possible to make use of only 6 digits (each 14 segment alphanumeric) for display application. Messages are abbreviated as described below.

Table 2

Abbreviation of Message Displayed on LCD	**Meaning of Message**	Description of Message
Function Adjust Messages		
ADJ_MD	Adjust Mode	Indicates the mode in which the menu of parameters to be adjusted has been selected
	Display Mode	
DSP_MD		Indicates the mode in which the menu of parameters to be displayed has been selected
SL_ADJ	Select Adjust mode	This message indicates that 'Adjust mode' has been selected

Abbreviation of Message Displayed on LCD	**Meaning of Message**	Description of Message
HR_ADJ	Hour Adjust	This message indicates that ‘Hour’ parameter of the clock has to be adjusted.
MN_ADJ	Minute Adjust	This message indicates that ‘Minute’ parameter of the clock has to be adjusted.
AH_ADJ	Alarm Hour Adjust	This message indicates that ‘Alarm Hour’ has to be adjusted.
AM_ADJ	Alarm Minute Adjust	This message indicates that ‘Alarm Minute’ has to be adjusted.
AL_E_D	Alarm Enable/Disable	This message indicates that alarm sound has to be enabled or disabled after setting alarm time.
DY_ADJ	Day Adjust	This message indicates that ‘Day’ of calendar week has to be adjusted.
DT_ADJ	Date Adjust	This message indicates that ‘Date’ of calendar week has to be adjusted.
MT_ADJ	Month Adjust	This message indicates that ‘Month’ of calendar year has to be adjusted.
YR_ADJ	Year Adjust	This message indicates that ‘Year’ of calendar has to be adjusted.
Messages for Displaying Parameters		

Abbreviation of Message Displayed on LCD	**Meaning of Message**	Description of Message
DP_TMP	Display Temperature	This message indicates user that display of Temperature in ‘ºF’ can be selected.
DP_HUM	Display Humidity	This message indicates that display of Humidity in ‘RH’ can be selected
DP_ALT	Display Alarm Time	This message indicates that display of previously set ‘Alarm Time’ can be viewed.
DP_DAY	Display Day	This message indicates that display of previously set calendar ‘Day’ can be viewed.
DP_DAT	Display Date	This message indicates that display of previously set calendar ‘Date’ can be viewed.
DP_TIM	Display Time	This message indicates that display of latest ‘Time’ can be viewed.
AL_STP	Alarm Stop	This message indicates that Alarm Beep has been stopped
AL_ENB	Alarm Enable	This message indicates that Alarm has been enabled
AL_DSB	Alarm Disable	**This message indicates that Alarm has been disabled. Even if Alarm time has been set, it will not produce alarm beep sound, since user might have already disabled the alarm by pressing/selecting AL_E_D**
-DONE_	Selection done	This message indicates current task has been completed and done.

Abbreviation of Message Displayed on LCD	**Meaning of Message**	Description of Message
INVALD	Invalid	This message indicates pushbutton switch pressed is ‘Invalid’
Status messages		
ALT_IS	Alarm is	This message appears just before the display of Alarm Time
TIM_IS	Time is	This message appears just before the display of Time
TMP_IS	Temperature is	This message appears just before the display of Temperature.
HUMIDIT	Humidity	This message appears just before the display of the parameter ‘Humidity’
DAY_IS	Day is	This message appears just before the display of Day of the week.
DAT_IS	Date is	This message appears just before the display of Date.

2.3 Getting Started

MB89P568 Demo board packaged in an acrylic case includes an acrylic stand to keep the board in comfortable position for using it as a table top clock. It also includes three AAA batteries.

2.3.1 Battery connections:

Rear side of the board is equipped with a battery holder. Three AAA batteries each of 1.5V to be inserted in the battery holder. While inserting batteries in the battery holder, take care of '+' and '-' markings on the battery holder. Once batteries are inserted in correct position, demo board is ready to be used.

2.3.2 Display

Once board gets 4.5V supply from batteries, press 'RESET' (S1) pushbutton switch to ensure that microcontroller and other devices on the board are initialized.

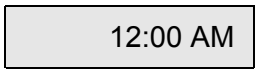
2.3.2.1 Scrolling message display

Once the board is initialized, you will be able to see welcome greetings **'WELCOME TO FUJITSU MICROELECTRONICS AMERICA INC '**message starts scrolling on 6 digit LCD panel.

This scrolling message later periodically repeats once per around every 30 minutes.

2.3.2.3 Clock display

After the end of scrolling message, clock display starts. Default clock start at 12.00am as shown below.



2.3.2.3.1 CLOCK ADJUSTMENT

Follow below procedure to adjust the clock to the required time.

- **Adjustment of 'Time Hour':** Diagram of functional switches is shown in **Figure 3: Layout of Switches3**

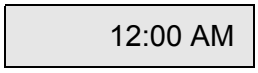
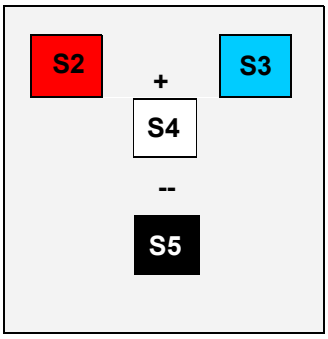


Figure 3: Layout of Switches



1. To adjust ‘Time Hour’ parameter, press red push button switch ‘Function Select’ (Switch S2). ‘ADJ_MOD’ message appears on LCD. This means the board is now in ‘Adjust mode’.

ADJ_MOD

S2

Now user will be able to select the parameter that he is interested to change.

2. Now press blue switch ’Enter’ (Switch S3) to indicate the acceptance for being in that mode.

S3

3. Message ‘SL_ADJ’ appears on display.

SL_ADJ

Press white push button switch ‘+’ (switch S4) or black push button switch ‘__’ (switch S5) till message ‘HR_ADJ’ appears on display.

OR

+ S4

-- S5

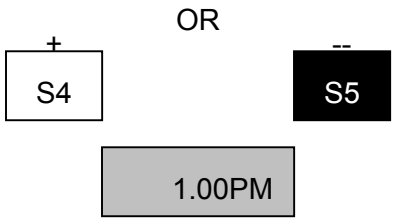
HR_ADJ

4. Now press blue push button switch ‘Enter’. ‘SELCTD’ appears on display.

S3

SELCTD

5. Press white pushbutton switch '+' to increase the 'Hour' value of time as required.



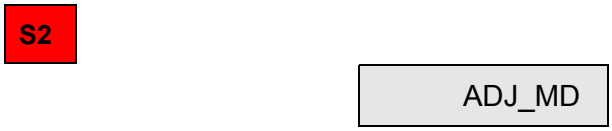
For example, display appears as above, while adjusting hour of time

3. Press blue pushbutton switch 'Enter' to indicate the end of adjustment. '-DONE-' message appears on display. Depending on the adjusted time, AM changes to PM or vise versa.

- **Adjustment of 'Time Minute':**

1. To adjust 'Time Minute' parameter, press red push button switch 'Function Select' (Switch S2).

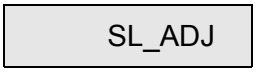
'SP_MOD' message appears on LCD. This means the board is now in 'Adjust parameter' mode.



Now user will be able to select the parameter that he is interested to change.

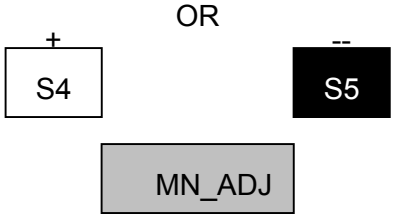
2. Now press blue switch' Enter' (Switch S3) to indicate the acceptance for being in that mode.

3. Message 'SL_ADJ' appears on display.



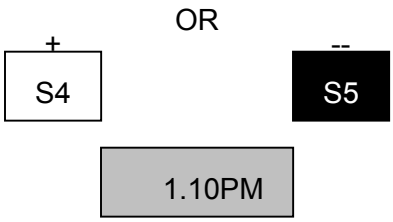
Press white push button switch '+' (switch S4) or black push button switch '__' (switch S5) till message 'MN_ADJ' appears on display.

.



4. Now press blue push button switch ‘Enter’. ‘SELCTD’ appears on display.

5. Press white pushbutton switch ‘+’ to increase the ‘minute’ value of time as required.



For example, display appears as above, while adjusting minute value of time

6. Press blue pushbutton switch ‘Enter’ to indicate the end of adjustment. ‘-DONE-‘ message appears on display.

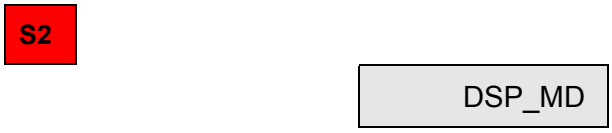
2.3.2.3.2 DISPLAY OF TIME

This is an addition option to display time. Since by default Time is always displayed, this might be used very rarely. Please refer following steps to display the time.

1. Press red push button switch ‘Function Select’ (Switch S2).

‘DSP_MOD’ message appears on LCD. This means the board is now in ‘Display mode’ and is

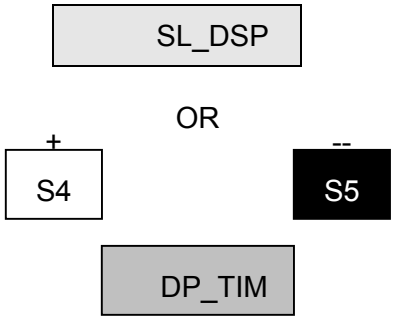
ready to display selected parameters.



Now user will be able to select the parameter that he is interested to change.

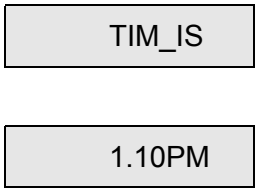
2. Now press blue switch’ Enter’ (Switch S3) to indicate the acceptance for being in that mode.

3. Message ‘SL_DSP’ appears on display. Press white push button switch ‘+’ (switch S4) or black push button switch ‘__’ (switch S5) till message ‘DP_TIM’ appears on display.



4. Now press blue push button switch ‘Enter’

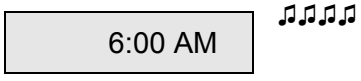
5. Following message and then time appear as below.



6. Press blue pushbutton switch ‘Enter’ to indicate the end of display mode.

2.3.2.3 Alarm Time Display

Alarm time by default is adjusted to 6.00 AM. If time is 6.00AM, and also if Alarm is Enabled by selecting ‘AL_ENB’ function, then only alarm beeps.



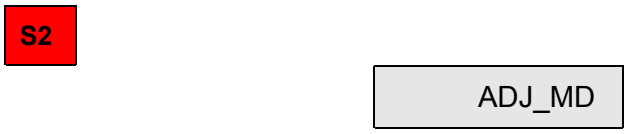
2.3.2.3.1 ALARM ADJUSTMENT

Follow below procedure to adjust the alarm to the required time.

- **Adjustment of ‘Alarm Hour’:** Diagram of functional switches is shown in **Figure 3: Layout of Switches3**.

1. To adjust ‘Alarm Hour’ parameter, press red push button switch ‘Function Select’ (Switch S2).

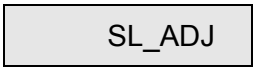
‘ADJ_MD’ message appears on LCD. This means the board is now in ‘Adjust parameter’ mode.



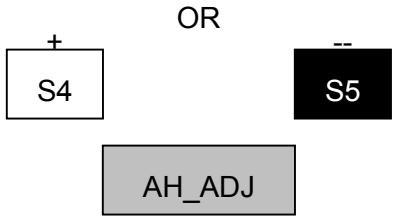
Now user will be able to select the parameter that he is interested to change.

2. Now press blue switch’ Enter’ (Switch S3) to indicate the acceptance for being in that mode.

3. Message ‘SL_ADJ’ appears on display..

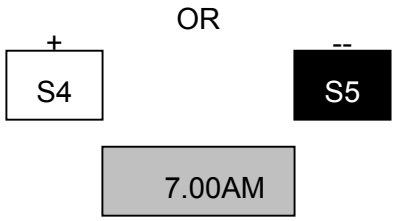


Press white push button switch ‘+’ (switch S4) or black push button switch ‘__’ (switch S5) till message ‘AH_ADJ’ appears on display



4. Now press blue push button switch ‘Enter’. ‘SELCTD’ appears on display.

5. Press white pushbutton switch ‘+’ to increase the ‘Hour’ value of alarm time as required.



For example, display appears as above, while adjusting hour of time

6. Press blue pushbutton switch 'Enter' to indicate the end of adjustment. '-DONE-' message appears on display. Depending on the adjusted time, AM changes to PM or vise versa.

- **Adjustment of 'Alarm Minute':**

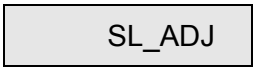
1. To adjust 'Time Minute' parameter, press red push button switch 'Function Select' (Switch S2).

'ADJ_MD' message appears on LCD. This means the board is now in 'Select parameter' mode.

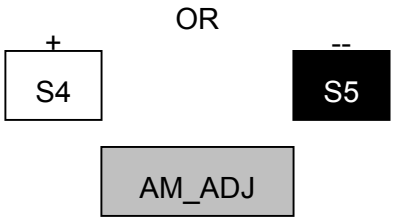
Now user will be able to select the parameter that he is interested to change.

2. Now press blue switch' Enter' (Switch S3) to indicate the acceptance for being in that mode.

3. Message 'SL_ADJ' appears on display.



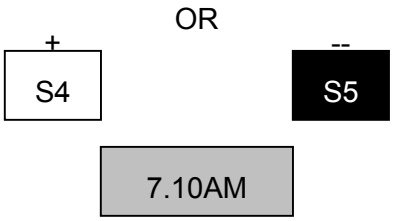
Press white push button switch '+' (switch S4) or black push button switch '__' (switch S5) till message 'AM_ADJ' appears on display.



4. Now press blue push button switch 'Enter'. 'SELCTD' appears on display

.

5. Press white pushbutton switch '+' to increase the 'minute' value of alarm time as required.



For example, display appears as above, while adjusting minute value of time

6. Press blue pushbutton switch 'Enter' to indicate the end of adjustment. '-DONE-' message appears on display.

- **Adjusted Alarm Enable**

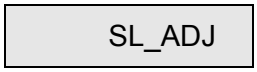
1. To adjust 'Time Minute' parameter, press red push button switch 'Function Select' (Switch S2).

'ADJ_MD' message appears on LCD. This means the board is now in 'Adjust parameter' mode.

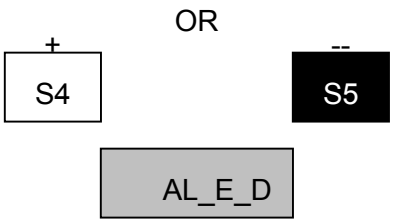
Now user will be able to select the parameter that he is interested to change.

2. Now press blue switch' Enter' (Switch S3) to indicate the acceptance for being in that mode.

3. Message 'SL_ADJ' appears on display.

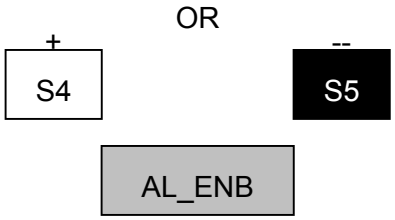


Press white push button switch '+' (switch S4) or black push button switch '__' (switch S5) till message 'AL_E_D' appears on display.



4. Now press blue push button switch ‘Enter’. ‘SELCTD’ appears on display.

5. Press white pushbutton switch ‘+’ to select the option for enabling alarm



For example, display appears as above.

6. Press blue pushbutton switch ‘Enter’ to indicate the end of adjustment. ‘-DONE-‘ message appears on display.

- **Adjusted Alarm Disable**

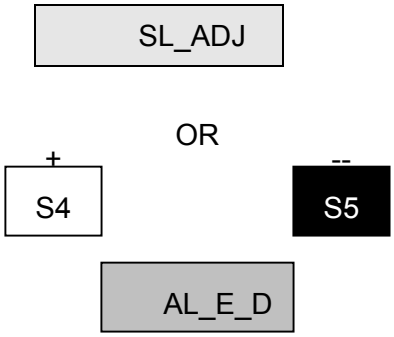
1. To adjust ‘Time Minute’ parameter, press red push button switch ‘Function Select’ (Switch S2).

‘ADJ_MD’ message appears on LCD. This means the board is now in ‘Select parameter’ mode.

Now user will be able to select the parameter that he is interested to change.

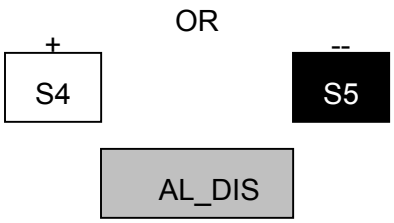
2. Now press blue switch’ Enter’ (Switch S3) to indicate the acceptance for being in that mode.

3. Message ‘SL_ADJ’ appears on display. Press white push button switch ‘+’ (switch S4) or black push button switch ‘__’ (switch S5) till message ‘AL_E_D’ appears on display.



4. Now press blue push button switch ‘Enter’. ‘SELCTD’ appears on display.

5. Press white pushbutton switch ‘+’ to select the option for disabling alarm.



For example, display appears as above, while disabling the Alarm, so that it will not make alarm beep sound.

6. Press blue pushbutton switch ‘Enter’ to indicate the end of adjustment. ‘-DONE-‘ message appears on display.

2.3.2.3.1 DISPLAY OF ALARM TIME

This feature is to display already set alarm time. Please refer following steps to display the alarm time.

1. Press red push button switch ‘Function Select’ (Switch S2).

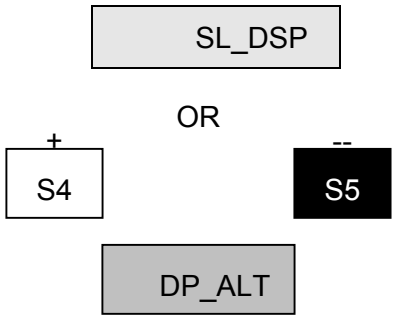
‘DSP_MOD’ message appears on LCD. This means the board is now in ‘Display mode’ and is

ready to display selected parameters.

Now user will be able to select the parameter that he is interested to change.

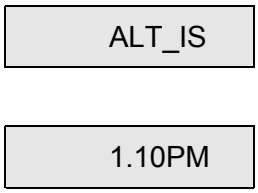
2. Now press blue switch’ Enter’ (Switch S3) to indicate the acceptance for being in that mode.

3. Message ‘SL_DSP’ appears on display. Press white push button switch ‘+’ (switch S4) or black push button switch ‘__’ (switch S5) till message ‘DP_TIM’ appears on display.



4. Now press blue push button switch ‘Enter’

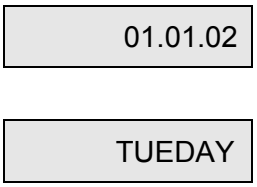
5. Following message and time appear as below.



6. Press blue pushbutton switch ‘Enter’ to indicate the end of display mode.

2.3.2.4 Calendar display

Board has the feature to display day, date, month and year. Default date set is 01.01.02 that is January 1st, 2002 and day is Tuesday.



2.3.2.4.1 CALENDAR ADJUSTMENT

Below is the procedure for changing required day, date, month and year.

- Adjustment of ‘Day’: Diagram of functional switches is shown in **Figure 3: Layout of Switches**

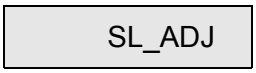
1. To adjust ‘Day’ parameter, press red push button switch ‘Function Select’ (Switch S2).

‘ADJ_MD’ message appears on LCD. This means the board is now in ‘Adjust parameter’ mode.

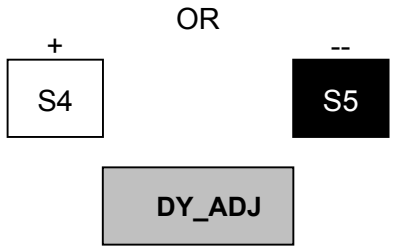
Now user will be able to select the parameter that he is interested to change.

2. Now press blue switch’ Enter’ (Switch S3) to indicate the acceptance for being in that mode.

3. Message ‘SL_ADJ’ appears on display.

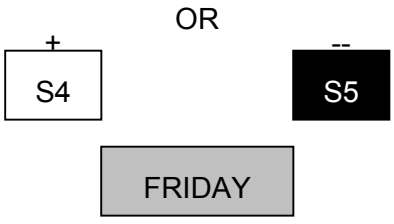


Press white push button switch ‘+’ (switch S4) or black push button switch ‘__’ (switch S5) till message ‘DY_ADJ’ appears on display.



4. Now press blue push button switch ‘Enter’. ‘SELCTD’ appears on display.

5. Press white pushbutton switch ‘+’ to choose the required ‘Day’ of a week.



For example, display appears as above, while adjusting day to ‘FRIDAY’

6. Press blue pushbutton switch ‘Enter’ to indicate the end of adjustment. ‘-DONE-‘ message appears on display.

- **Adjustment of ‘Date’:**

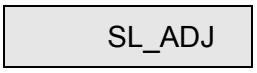
1. To adjust ‘Day’ parameter, press red push button switch ‘Function Select’ (Switch S2).

‘ADJ_MD’ message appears on LCD. This means the board is now in ‘Select parameter’ mode.

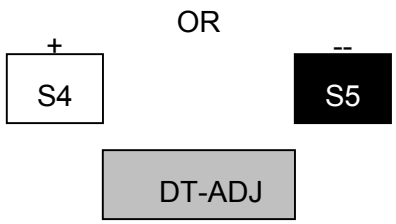
Now user will be able to select the parameter that he is interested to change.

2. Now press blue switch’ Enter’ (Switch S3) to indicate the acceptance for being in that mode.

3. Message ‘SL_ADJ’ appears on display.

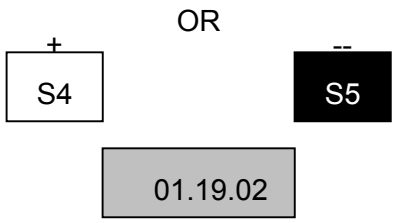


Press white push button switch ‘+’ (switch S4) or black push button switch ‘__’ (switch S5) till message ‘DT_ADJ’ appears on display.



4. Now press blue push button switch ‘Enter’. ‘SELCTD’ appears on display.

5. Press white pushbutton switch ‘+’ to choose the required ‘Date’ of the month.



For example, display appears as above, while adjusting date to 19th.

6. Press blue pushbutton switch 'Enter' to indicate the end of adjustment. '-DONE-' message appears on display.

- **Adjustment of 'Month'**

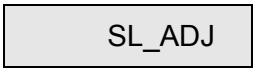
1. To adjust 'Day' parameter, press red push button switch 'Function Select' (Switch S2).

'ADJ_MD' message appears on LCD. This means the board is now in 'Adjust parameter' mode.

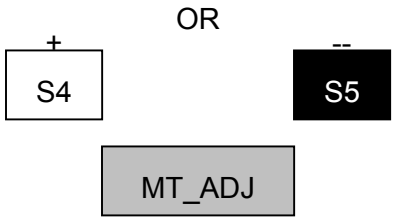
Now user will be able to select the parameter that he is interested to change.

2. Now press blue switch' Enter' (Switch S3) to indicate the acceptance for being in that mode.

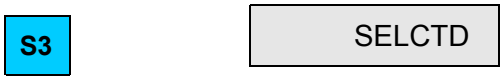
3. Message 'SL_ADJ' appears on display.



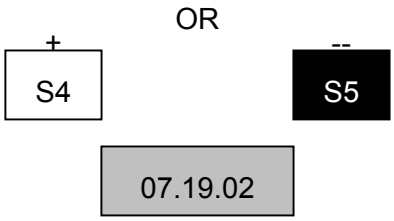
Press white push button switch '+' (switch S4) or black push button switch '__' (switch S5) till message 'MT_ADJ' appears on display.



4. Now press blue push button switch 'Enter'. 'SELCTD' appears on display.



5. Press white pushbutton switch '+' to choose the required 'month' of the year.



For example, display appears as above, while adjusting month to'7'.

6. Press blue pushbutton switch 'Enter' to indicate the end of adjustment. '-DONE-' message appears on display.

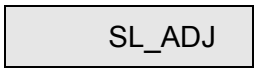
- **Adjustment of 'Year'**

1. To adjust 'Day' parameter, press red push button switch 'Function Select' (Switch S2). 'ADJ_MD' message appears on LCD. This means the board is now in 'Adjust parameter' mode.

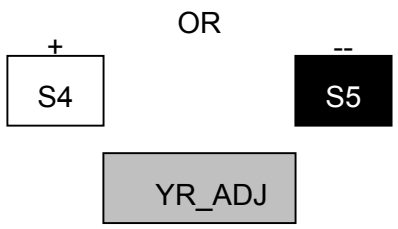
Now user will be able to select the parameter that he is interested to change.

2. Now press blue switch' Enter' (Switch S3) to indicate the acceptance for being in that mode.

3. Message 'SL_ADJ' appears on display.

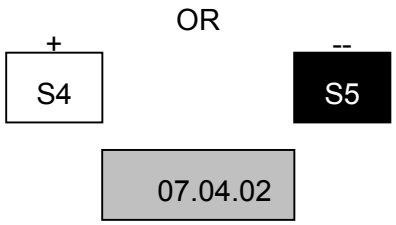


Press white push button switch '+' (switch S4) or black push button switch '__' (switch S5) till message 'YR_ADJ' appears on display



4. Now press blue push button switch ‘Enter’. ‘SELCTD’ appears on display.

5. Press white pushbutton switch ‘+’ to choose the required year.



For example, display appears as above, while adjusting year. If change of year value is not required, just press ‘Enter’.

6. Press blue pushbutton switch ‘Enter’ to indicate the end of adjustment. ‘-DONE-‘ message appears on display.

2.3.2.3.1 DISPLAY OF CALENDAR

This is an additional feature provided to display previously set Day and Date.

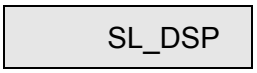
Display of Day

1. Press red push button switch ‘Function Select’ (Switch S2). ‘DSP_MOD’ message appears on LCD. This means the board is now in ‘Display mode’ and is ready to display selected parameters.

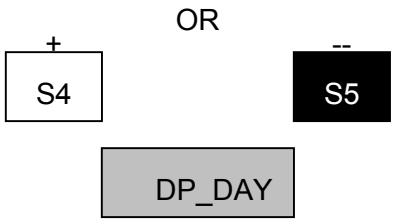
Now user will be able to select the parameter that he is interested to change.

2. Now press blue switch’ Enter’ (Switch S3) to indicate the acceptance for being in that mode.

3. Message ‘SL_DSP’ appears on display.

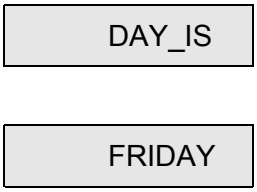


Press white push button switch ‘+’ (switch S4) or black push button switch ‘__’ (switch S5) till message ‘DP_DAY’ appears on display.



4. Now press blue push button switch ‘Enter’

5. Following message and time appear as below.



6. Press blue pushbutton switch ‘Enter’ to indicate the end of display mode.

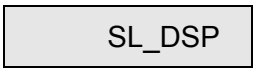
- **Display of Date**

1. Press red push button switch ‘Function Select’ (Switch S2). ‘DSP_MOD’ message appears on LCD. This means the board is now in ‘Display mode’ and is ready to display selected parameters.

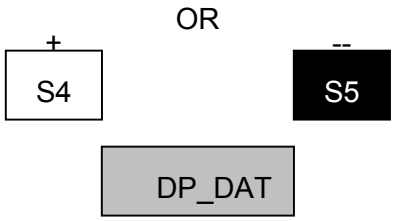
Now user will be able to select the parameter that he is interested to change.

2. Now press blue switch' Enter' (Switch S3) to indicate the acceptance for being in that mode.

3. Message 'SL_DSP' appears on display.

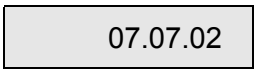


Press white push button switch '+' (switch S4) or black push button switch '__' (switch S5) till message 'DP_DAT' appears on display.



4. Now press blue push button switch 'Enter'

5. Following message and time appear as below.



6. Press blue pushbutton switch 'Enter' to indicate the end of display mode.

2.3.2.5 Temperature display

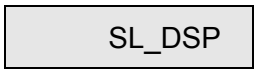
Temperature in ºC is displayed whenever user wants to display temperature by following below procedure.

1. Press red push button switch 'Function Select' (Switch S2). 'DSP_MOD' message appears on LCD. This means the board is now in 'Display mode' and is ready to display selected parameters.

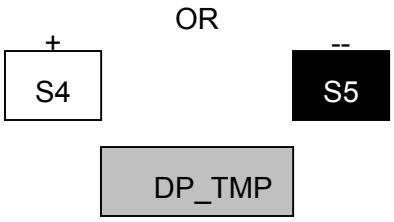
Now user will be able to select the parameter that he is interested to change.

2. Now press blue switch' Enter' (Switch S3) to indicate the acceptance for being in that mode.

3. Message 'SL_DSP' appears on display.

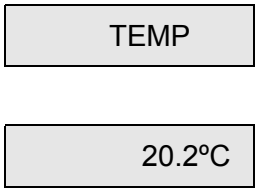


Press white push button switch '+' (switch S4) or black push button switch '__' (switch S5) till message 'DP_TMP' appears on display.



4. Now press blue push button switch 'Enter'

5. Following message and time appear as below.



6. Press blue pushbutton switch ‘Enter’ to indicate the end of display mode.

2.3.2.6 Humidity display

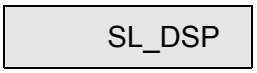
Humidity in RH is displayed whenever user wants to display humidity by following below procedure.

1. Press red push button switch ‘Function Select’ (Switch S2). ‘DSP_MOD’ message appears on LCD. This means the board is now in ‘Display mode’ and is ready to display selected parameters.

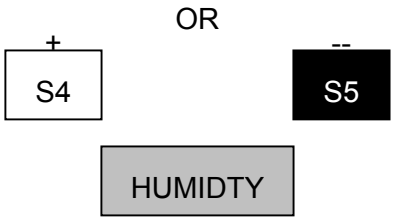
Now user will be able to select the parameter that he is interested to change.

2. Now press blue switch’ Enter’ (Switch S3) to indicate the acceptance for being in that mode.

3. Message ‘SL_DSP’ appears on display.

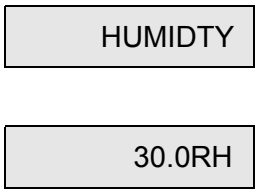


Press white push button switch ‘+’ (switch S4) or black push button switch ‘__’ (switch S5) till message ‘HUMIDTY’ appears on display.



4. Now press blue push button switch ‘Enter’

5. Following message and time appear as below.



6. Press blue pushbutton switch ‘Enter’ to indicate the end of display mode.

2.4 Note

- In each of the above cases of adjustment/display of parameters, when push button switch other than mentioned in above sequences ahs been pressed, message ‘Invalid’ appears on LCD. This indicates that invalid key has been pressed.

. In such cases, just press ‘Enter’ key. ‘Done’ message appears and display returns to normal Clock mode.

- Humidity and temperature measurement values may not be very accurate and may vary due to variation in supply voltage, battery drain, and variation in AVref to A/D converter of MCU and also due to nonlinear output of sensors. Humidity and temperature measurement is meant to show the capabilities of MCU for such kind of applications.
- VR1 is provided on the board for intensity adjustment of LCD. If battery voltage starts falling, intensity might reduce. In such case VR1 can be used. Clock and Calendar functions even with 3V battery or regulated supply. But note that VR1 should be adjusted in such case. But with 3V power supply humidity and temperature measurements can not be made due to internal A/D of MCU voltage requirement.

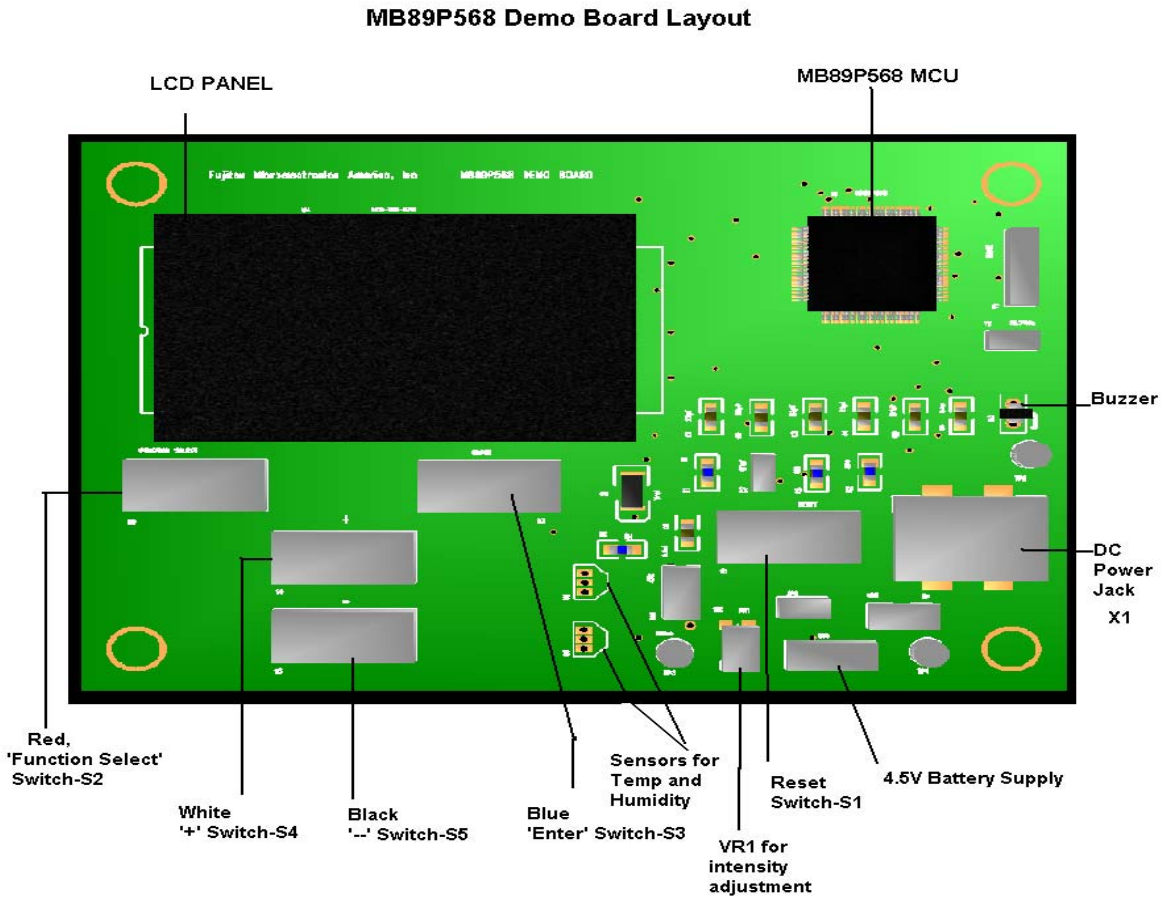
3 Hardware Specifications

3.1 Power Supply Requirement

Three AAA batteries provide 4.5V power supply voltage to the board. There is an option for mounting DC power jack X1 on the board instead of batteries. Then care should be taken that the regulated power supply of 4.5 V should be supplied after disconnecting wire leads to battery or making use of ON/OFF switch on battery holder residing on backside of the board . Power indicator 'D1' green LED glows only when jumper 'J1' is shorted. For providing higher resolution for displaying temperature and humidity, the internal A/D converter of the micro-controller requires minimum voltage higher than 3.2V. Therefore, 4.5V regulated power supply or 4.5 V battery output meets the voltage requirements The MB89P568

Demo board with above features supports the FPT-80P-M05 square QFP 80 pin, 14x14mm package with 0.5mm pitch

Figure 4: Board layout



Error! Reference source not found. shows detailed board layout where all mounted devices are marked.

3.2 Clock

The board operates with high-speed main clock of 10MHz and low speed sub clock of 32.768 KHz. To implement the real-time clock watch pre-scalar is used. Watch pre-scalar provides interval timer functions. It uses a 17 bit free running counter, which counts in sync with a sub clock. Program interval time divided clock output is selected as 1sec using sub clock source oscillation. The entire program uses main clock except watch pre-scalar and LCD controller.

Enable and stop of main and sub clock oscillations are controlled by clock and stop modes. The board functions in low power sleep mode. Switching from normal to low power mode is taken care in software.

3.3 LCD

LCD used is 14-segment alphanumeric display VIM-878-RC-S. MB89P568 MCU is having on chip 24 x 4 pixels LCD controller/Driver. The chosen LCD panel is having 128 pixels (8 digits and each digit has 14 segments for displaying alphanumeric characters). However, MB89P568 is capable of driving 96 pixels, maximum of 6 digits of the LCD panel can be utilized for displaying the message. Refer APPENDIX for schematic diagram. 24 segments and 4 common pins of the LCD are directly connected to corresponding 24 segment and 4 common pins of MCU MB89P568. LCD is suitable only for operating in 1/3 bias, ¼ duty ratio, and multiplex mode with MCU. 10Kohms potentiometer is connected to V3 drive pin of MCU for intensity adjustment of the LCD.

For electrical specifications refer chapter 6.Following are the electrical specifications.

Characteristics:

- Manufacturer: Varitronix
- Fourteen segment alphanumeric monochrome display.
- Multiplex LV type with commercial TN display.
- Multiplex drive, 1/3 bias, ¼ duty ratio, no backlight
- Viewing angle 6 O' clock mode
- Since LV, operating voltage is typically 3.2 V. To maintain this voltage to drive LCD, VR1 is provided on the board.

3.4 Temperature Sensor

Temperature sensor U2 used along with the board is LM19-CIZ. This is a precision analog output CMOS temperature sensor that operates over -67ºF to 266ºF range. Analog linear output of sensor is connected to A/D converter AN0 input for conversion to digital value. Since the sensor is low cost, low power and output of the sensor being analog linear, it suits for our application. This sensor is used for measuring ambient temperature in ºF.

The LM19 is a precision analog output CMOS integrated-circuit temperature sensor that operates over a -55°C to +130°C temperature range. The power supply operating range is +2.4 V to +5.5 V. The transfer function of LM19 is predominately linear, yet has a slight predictable parabolic curvature. The accuracy of the LM19 when specified to a parabolic transfer function is ±2.5°C at an ambient temperature of +30°C. The temperature error increases linearly and reaches a maximum of ±3.8°C at the temperature range extremes. The power supply voltage affects the temperature range. At a power supply voltage of 2.7 V to 5.5 V the temperature range extremes are +130°C and -55°C. Decreasing the power supply voltage to 2.4 V changes the negative extreme to -30°C, while the positive remains at +130°C. The LM19's quiescent current is less than 10 µA. Therefore, self-heating is less than 0.02°C in still air.

Features

- Rated for full -55°C to +130°C range
- Available in a TO-92 package
- Predictable curvature error
- Manufacturer: National Semiconductor

For detailed package and specifications refer chapter 6

3.5 Humidity Sensor

Humidity Sensor U5 used is HIH-3630-101. This Relative humidity sensor from Honey well delivers high quality sensing performance. It is rugged, low cost and perfect for battery-powered systems since current drawn is only 200uA. Linear analog output of sensor is connected to AN1 input of A/D converter for conversion to digital value and also for displaying the same in %RH units. For details and specifications of this sensor, refer chapter 6.

Features:

- Linear output voltage versus %RH
- Low power, High accuracy
- Fast response time, stable
- Molded thermo set plastic housing

3.6 Buzzer

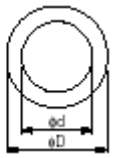
PPG of MCU is used for producing alarm sound. The software takes care of initializing PPG. Buzzer is connected to PPG2 output pin of the MCU. The alarm time could be adjusted by pressing the red push button switch ‘Function select’.

Buzzer EE27A-39A is piezo-ceramic buzzer diaphragm from FDK. FDK piezoceramic buzzers generate sound through the bending vibrations of a thin metal plate adhered to a piezoceramic disc. These buzzers feature low power consumption, a safe, spark-free and non-contact structure, and a small size and light weight for an easy mounting to printed circuit boards. It is external drive

type having resonant frequency of 3.9 KHz suitable to use with MCU having PPG macro for generating sound.

Package

External-drive type



Electrical Specifications of EE27A-39A:

Resonant Frequency: 3.9 KHz

Maximum input voltage: 30V, capacitance: 20,000 pF

Metal plate material: Brass

Weight: 1.6grams

Metal plate outer Diameter: 27mm

4 Software Details

4.1 LCD Demo Board program specifications

The specifications of the LCD demo program for MB89P568 assume the following conditions.

- MCU series: MB89560
- MCU MB89P568PFV-101 : FPT - 80P-M05 Package, without booster and with internal voltage divider.
    - Main Clock.: 10MHz
    - Sub Clock: 32.768KHz
- LCD Display Ports
    - SEG00 to SEG07 …….. Segment output ports
    - P50/SEG08 to P57/SEG15 ……. Segment output ports
    - P60/SEG16 to P67/SEG23 ……. Segment output ports
    - COM0 to COM3 ……. Common output ports

Operation outline:

To implement the clock demo on LCD display, watch pre-scalar is used. Watch pre-scalar provides interval timer functions. It uses a 17 bit free run counter that counts in sync with a sub clock. In this program, interval time divided clock output is selected as 1sec using sub clock source oscillation. The entire program uses main clock except watch pre-scalar and LCD controller.

1) Important Registers and RAM locations

Address	Register	Function
07H	SYCC	system clock control Register
0BH	WPCR	Watch pre-scalar control register
	PDR5	port 5 data register for segments
	PDR6	port 6 data register for segments
60 to 6BH	VRAM	LCD display data ram register
5BH	LCR1	LCD control register 1
5CH	LCR2	LCD control register 2
5DH	LCR3	LCD control registers 3
5EH	LDR1	LCD static control register

7BH	ILR1	Interrupt level set register
7DH	ILR3	Interrupt level set register
3FH	EIC1	External Interrupt Control Register1
40H	EIC2	External Interrupt Control Register2
38H	RCR21	PPG Control Registers
3AH	RCR22	
39H	RCR23	
3BH	RCR24	
34H	ADC1	ADC control registers
35H	ADC2	
36H	ADDL	ADC data registers
37H	ADDH	

2) Register Initialization

- Initializing the system clock control register SYCC

SYCC = 0x8F = 10001111: CS0: System operation clock = 0.2us

CS1

SCS: Sets the system clock to main mode

WT0: Oscillation stabilization time = 1.6ms

WT1

SCM: System clock monitor bits

- Initializing Watch pre scalar

WPCR = 0x46 =01000110: WCLR: clear

WS0: 1sec interval interrupt

WS1

WS1

WIE: Enable interrupt

WIF: clear watch interrupt flag

- **Initializing LCD control registers**

LCR1 = 0xEE = 11101110: FP0: Frame cycle selection bits = 64Hz

FP1

MS0: ¼ duty ratio

MS1

BK: Display un-blank

VSEL: Drive supply voltage control bit- Internal Resistor

LCDEN: Run in watch mode

CSD: Subclock

LCR2 = 0xC2= 11000010: FPS0: 64Hz

FPS1

LCS0: Static segment off

LCS1

LCS2

LCS3

LCSEN: Run in watch mode

CSS: Subclock

LCR3 = 0x10 = 00010000: LCD0: Segment 0-23 sel

LCD1

LCD2

LCD3

LCD4

LCS: reserved bit set '0'

LDR1 = 0x00 = not in static display mode

- Initialization of Interrupt level setting registers

ILR1 = 0xF8 =111110000 = IRQ0 at level1

IRQ1 at level2

IRQ3 and IRQ4 at level3

ILR3 = 0xBC = 10111100 = Watch pre scalar interrupt at level1

ADC at level2

IRQ9 and IRQA at default level3

- Initializing External interrupt control register

EIC1= 0x44 = 01000100 = clear interrupt request flag

Select falling edge

EIC2 = 0x44 = 01000100

- **Initializing PPG Control Register**

RCR21 = 0x1C= 00011100 = HSC0 to HCC5: High pulse compare value

RCK0, RCK1: 1 instr cycle

RCR22 = 0x02 = 00000010 = HSC6 to HSC11: High pulse width setting bits

RCR23 = 0x38 = 00111000 = SCL0 to SCL5: cycles compare value

RCR24 = 0x04 = 00000100 = SCL6 to SCL11: cycle setting bits

- Initializing ADC

ADC1 = 0x01=00000001 = AD: conversion activation

ADMV: conversion in progress flag

ADI: clear

ANS0: Select AN0 channel

ANS1

ANS2

ADC1= 0x11=00010001 = AD: conversion activation

ADMV: conversion in progress flag

ADI: clear

ANS0: Select AN1 channel

ANS1

ANS2

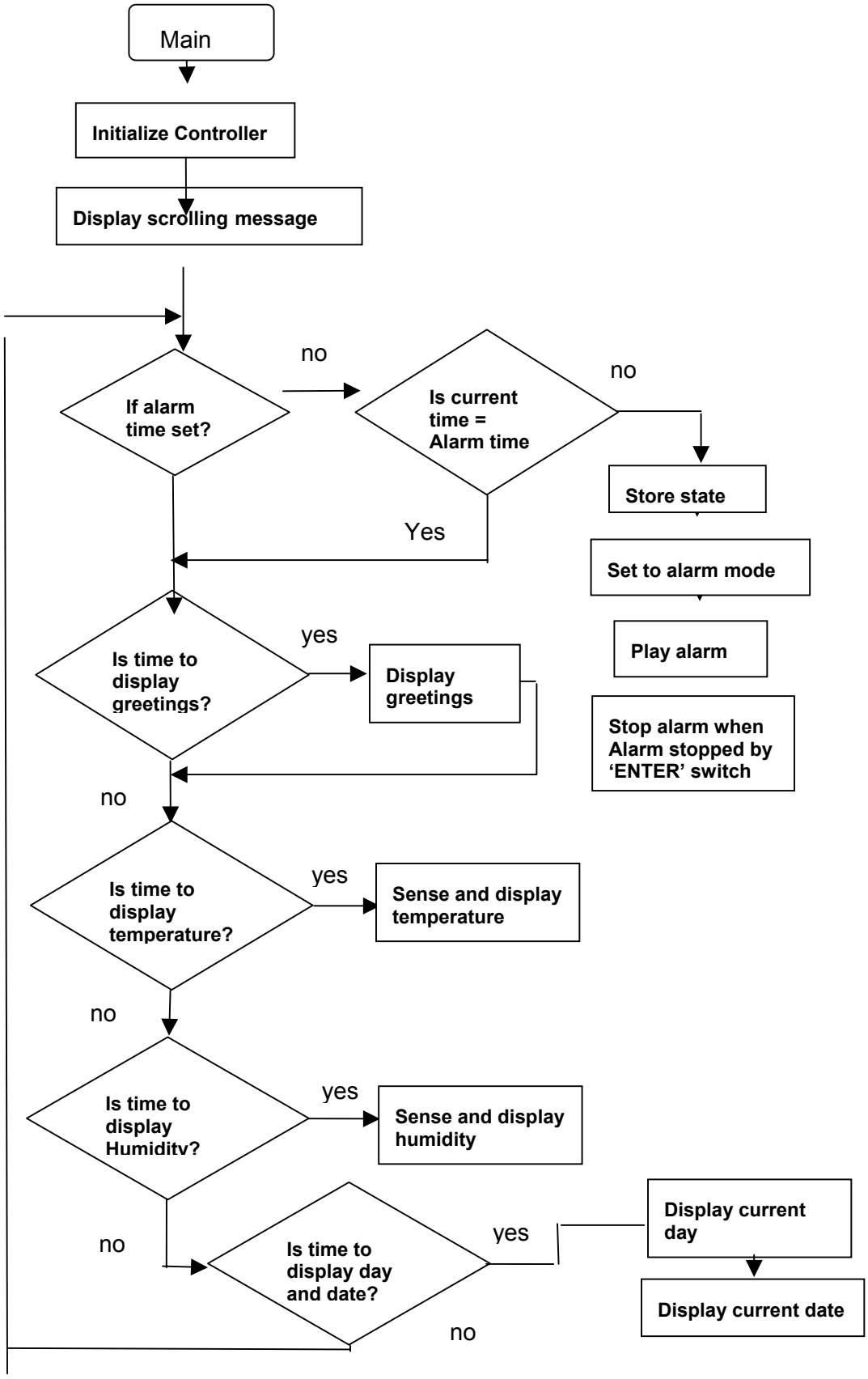
ADC2 = 0x09 = 00001001 = RESV: reserved bit

EXT: disable continuous activation

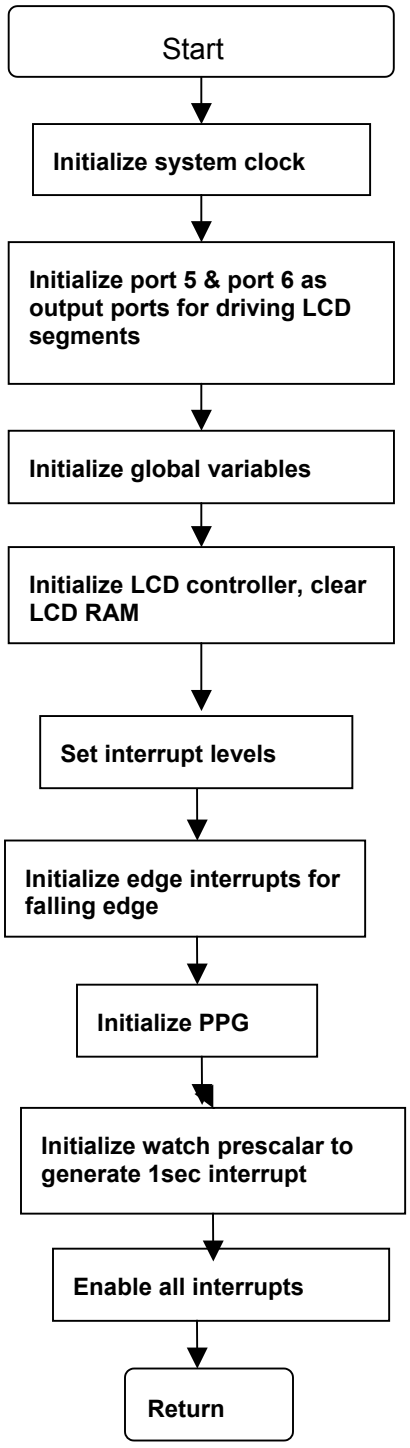
ADMD: ADC conversion

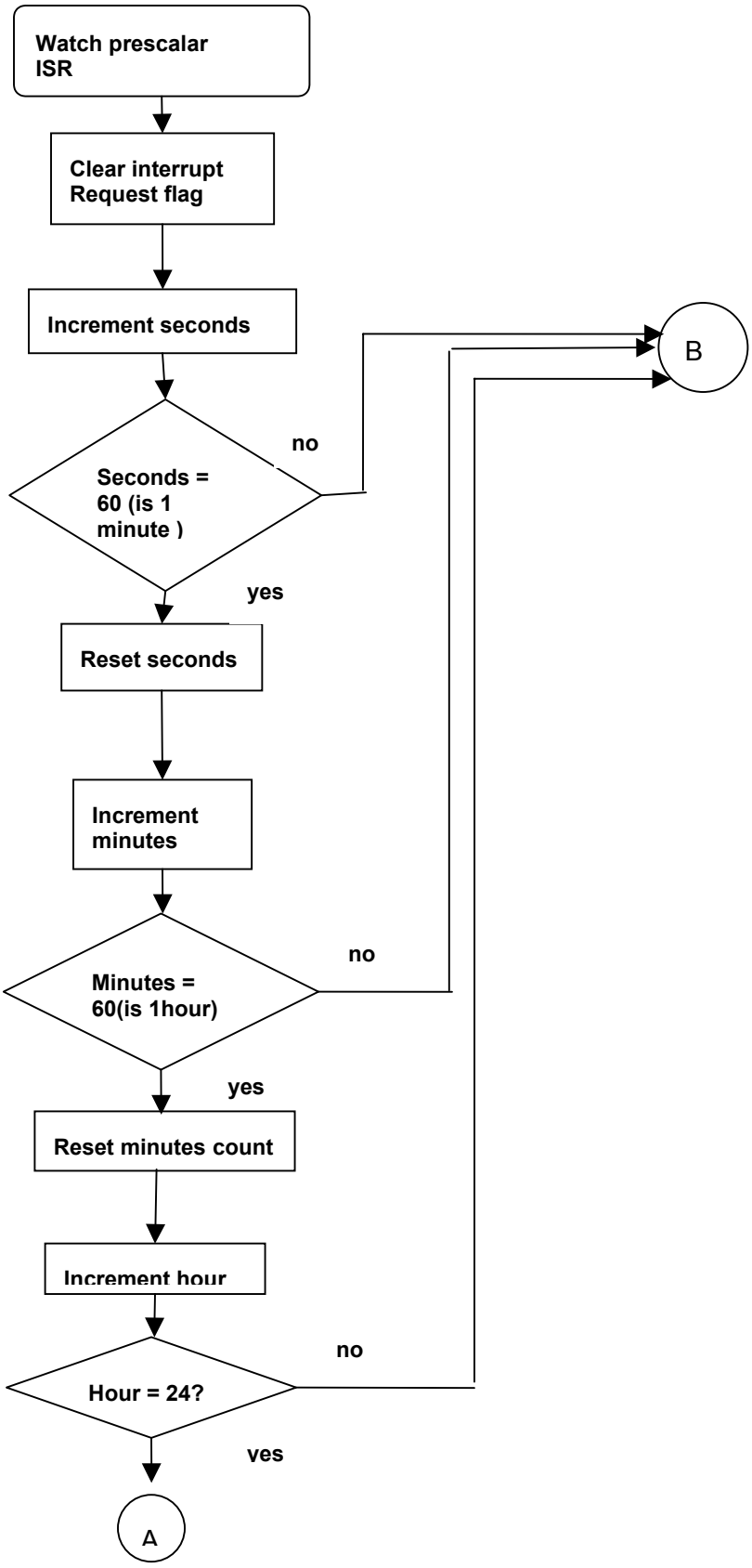
ADIE: interrupt request enable bit

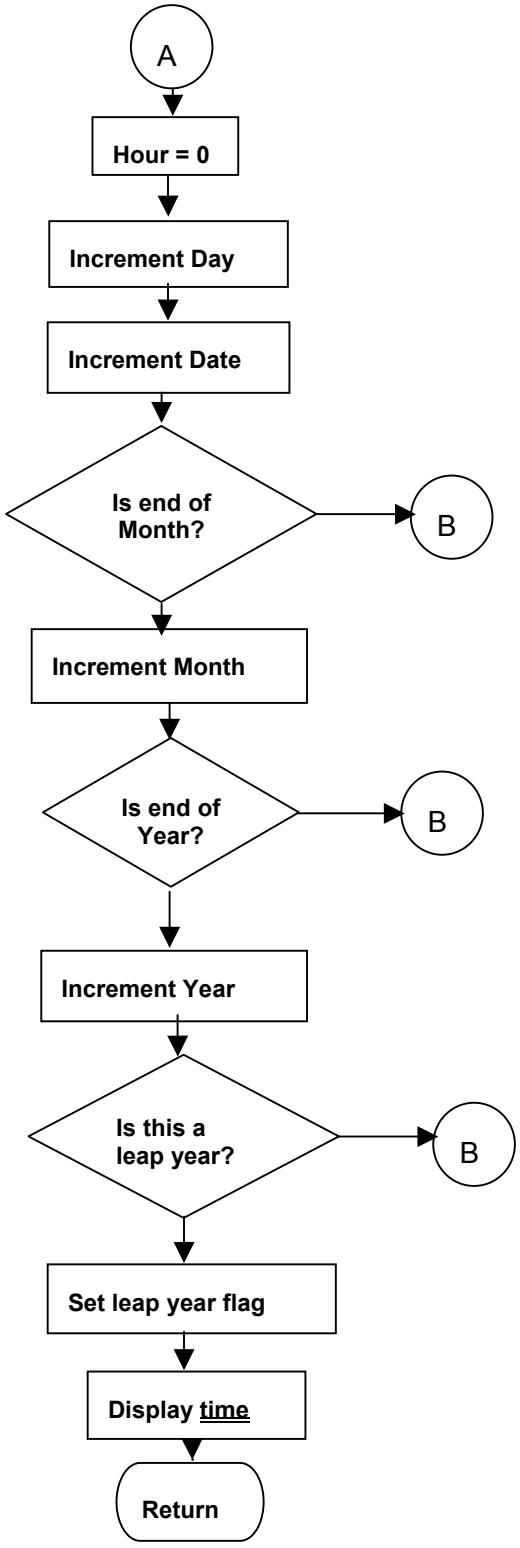
ADCK: ADC clock- time base timer output

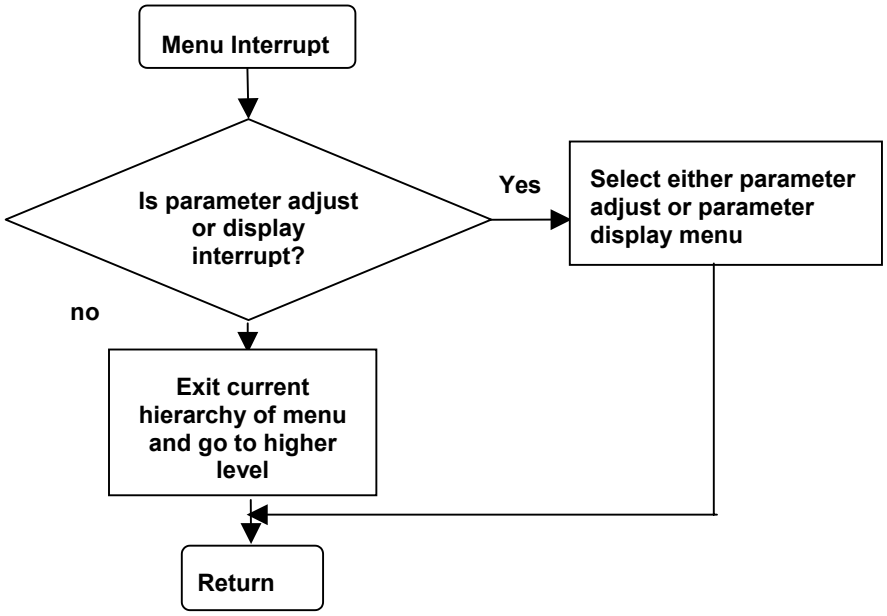

Main
Initialize Controller
Display scrolling message
If alarm time set?
no
Is current time = Alarm time
no
Store state
Yes
Set to alarm mode
Play alarm
Stop alarm when Alarm stopped by 'ENTER' switch
Is time to display greetings?
yes
Display greetings
no
Is time to display temperature?
yes
Sense and display temperature
no
Is time to display Humidity?
yes
Sense and display humidity
no
Is time to display day and date?
yes
Display current day
Display current date
no

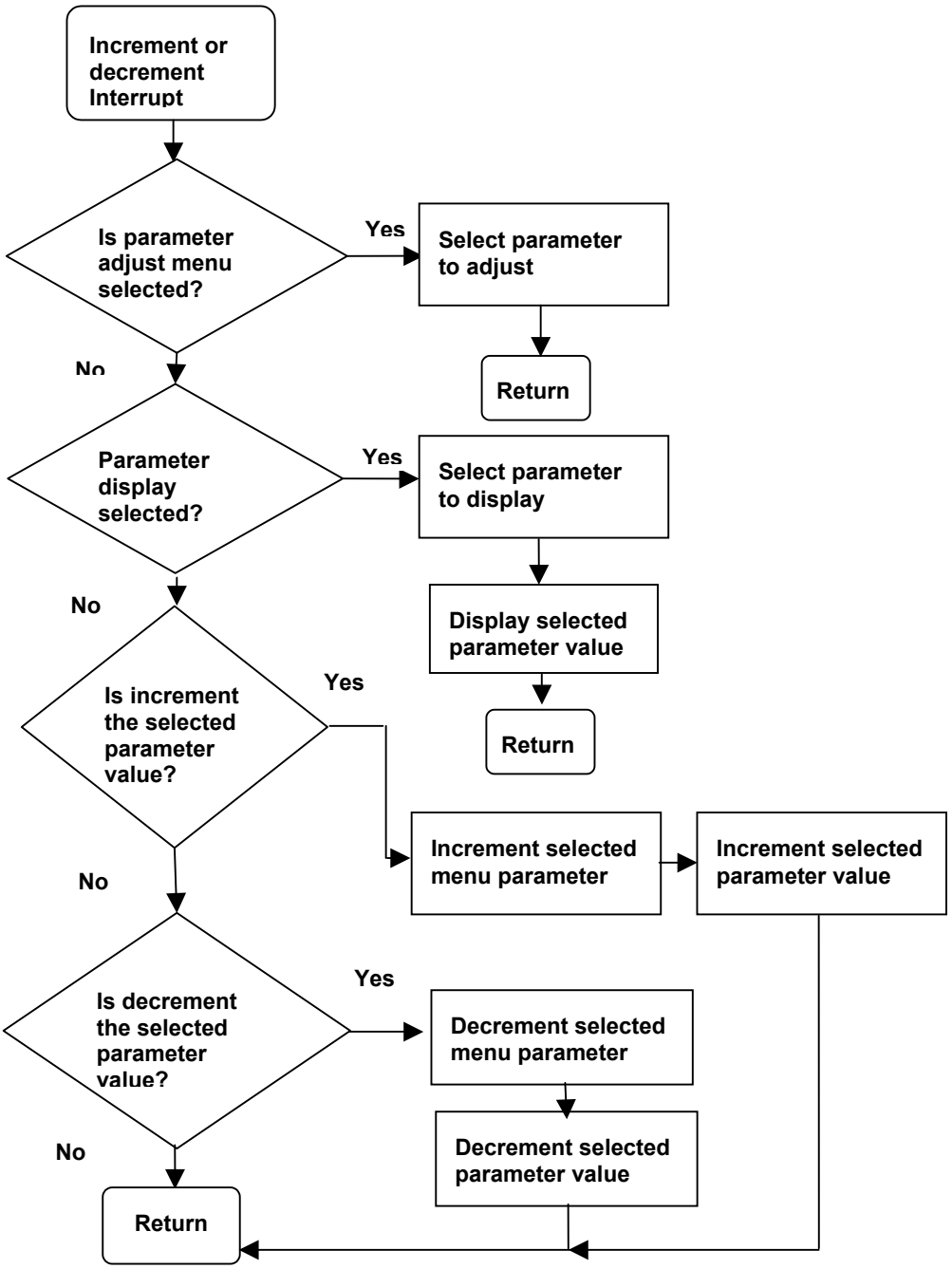
Initialization of Microcontroller


Start
Initialize system clock
Initialize port 5 & port 6 as output ports for driving LCD segments
Initialize global variables
Initialize LCD controller, clear LCD RAM
Set interrupt levels
Initialize edge interrupts for falling edge
Initialize PPG
Initialize watch prescalar to generate 1sec interrupt
Enable all interrupts
Return


Watch prescalar ISR
Clear interrupt Request flag
Increment seconds
B
no
Seconds = 60 (is 1 minute)
yes
Reset seconds
Increment minutes
no
Minutes = 60(is 1hour)
yes
Reset minutes count
Increment hour
no
Hour = 24?
ves
A


A
Hour = 0
Increment Day
Increment Date
Is end of Month?
B
Increment Month
Is end of Year?
B
Increment Year
Is this a leap year?
B
Set leap year flag
Display time
Return


Menu Interrupt
Is parameter adjust or display interrupt?
Yes
Select either parameter adjust or parameter display menu
no
Exit current hierarchy of menu and go to higher level
Return


Increment or decrement Interrupt
Is parameter adjust menu selected?
Yes
Select parameter to adjust
Return
No
Parameter display selected?
Yes
Select parameter to display
Display selected parameter value
Return
No
Is increment the selected parameter value?
Yes
Increment selected menu parameter
Increment selected parameter value
No
Is decrement the selected parameter value?
Yes
Decrement selected menu parameter
Decrement selected parameter value
No
Return

5 Acronyms

F2MC	Fujitsu Flexible Micro-Controller
ISR	Interrupt service routine
LCD	Liquid Crystal Display
MCU	Micro-Controller Unit
PPG	Programmable Pulse generator

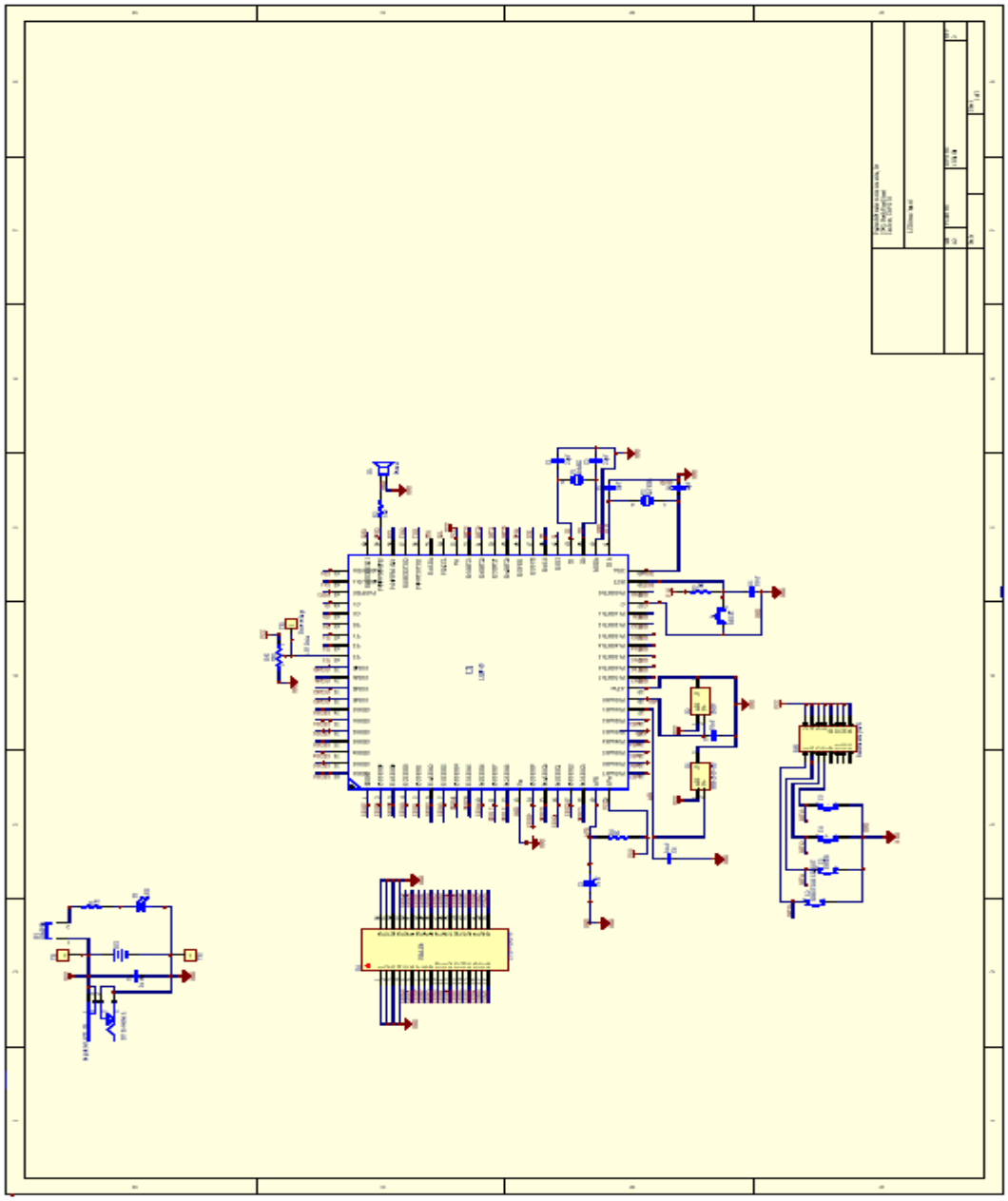
6 References

1. Fujitsu MCU CD Rom Ver: 3.3A for hardware manual and data sheets of MB89P568 F2MC-8L series Microcontroller.
2. www.varitronix.com/catalog/slcd1.html for specifications of LCD VIM-878-RC-S
3. www.national.com/pf/LM/LM19.html for Data sheets of LM19-CIZ
4. http://contents.honeywell.com/sensing/prodinfo/humiditymoisture/009012_2.pdf for specifications of Humidity Sensor HIH-3610-002
5. http://www.fdk.co.jp/cyber-e/pdf-e/ebuzzer.pdf for specifications of Piezoceramic Diaphragm EE27A-39A
6. Application note: 'Choosing Right LCD panel to be used with F2MC series having on-chip LCD controller/Driver'
7. Downloadable Software project files along with above Application note.

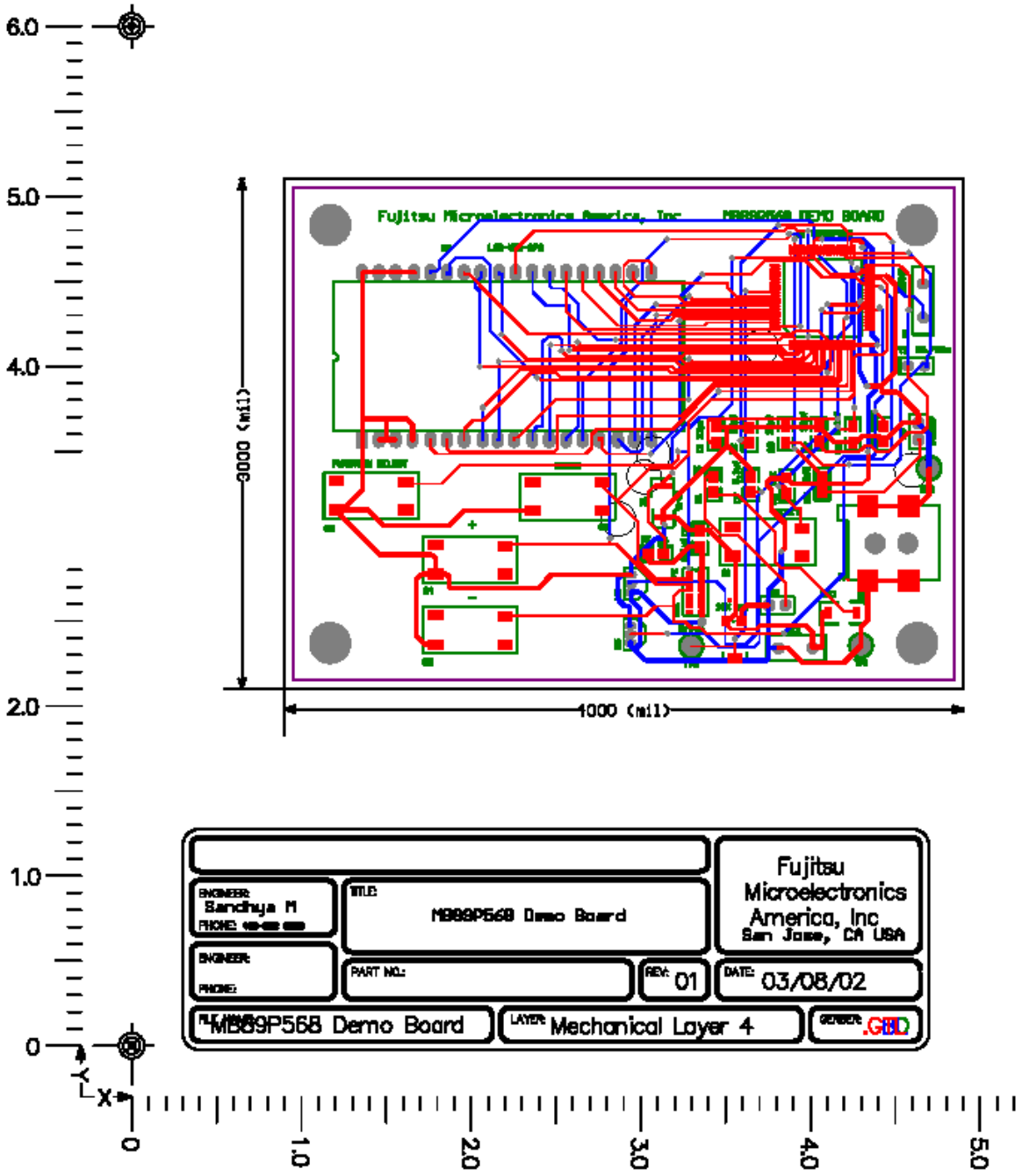
7 **Appendix:** Bill of Materials

Part Type	Designator	Footprint	Description	Details	Part Number
0.1uf	C7	805	Capacitor SMD	Digikey	BC1298CT-ND
0.1uf	C6	805	Capacitor SMD	Digikey	BC1298CT-ND
1K	R1	805	Resistor SMD	Digikey	311KFTRND
1K	R4	805	Resistor SMD	Digikey	3111KFTRND
10K	R3	805	Resistor SMD	Digikey	3111KFTRND
10K	VR1	SOT-23	Variable resistor Multiturn	Digikey	ST4B103CT-ND
10MHZ	Y1	XTAL1	Crystal	Digikey	X443-ND
22pf	C4	805	Capacitor SMD	Digikey	BC1260CT-ND
22pf	C2	805	Capacitor SMD	Digikey	BC1260CT-ND
22pf	C3	805	Capacitor SMD	Digikey	BC1260CT-ND
22pf	C1	805	Capacitor SMD	Digikey	BC1260Ct-ND
32.7KHz	Y2	RAD0.1	Crystal Cylinder	Digikey	300-1003-ND
0.1uf	C5	805	Capacitor SMD	Digikey	BC1298CT-ND
560	R2	805	Resistor SMD	Digikey	311560FTRND
Buzzer	U3	XDR1X2	Buzzer 4K	FDK Japar	EE27A-39A
CON9	RN1	RESARRAY	Resistor array pack 47K	Digikey	742C163473JTR
Decrement(-)	S5	SOT25	Tactile switches with CAP Blk	E-switch	TL3301SPF160QJ
ENTER	S3	SOT25	Tactile switches with CAP Blue	E-switch	TL3301SPF160QJ
Function	S2	SOT25	Tactile switches with CAP Red	E-switch	TL3301SPF160QJ
HIH-3610-002	U5	TO-92B	Humidity Sensor	Honeywell	HIH-3610-002
Increment(+)	S4	SOT25	Tactile switches with CAP Whit	E-switch	TL3310SPF160QJ
JUMPER	JP1	XDR1X2	Jumper	Digikey	
LCD-VIM-878	U4	MO-02040	VIM-878 LCD display	Varitronix	
LED	D1	3528	P504CT-ND green	Digikey	
LM19-CIZ	U2	TO-92B	Precision Temperature Sensor	National	Temp sensor LM19
LQFP1-80	U1	QFP80-14.2S50	LQFP-80 MCUMB89560	Fujitsu	MB89P568-19
RESET	S1	SOT25	Tactile switch Grey	E-switch	TL3301SPF160QJ
Powerjack	X1	POWERJACK	DC powerjack	Digikey	CP-002APJ-ND
Battery Holder				Digikey	BC4AAAL-ND
casing		Acrylic		Taplastics	Front/rear acrylic
Zener Diode	Z1	MELF1	Zener Diode, 4.3V, 1W	Digikey	ZM4731ADICT-ND
DC1	battery	RAD0.2	Battery connection		
Batteries	AAA 4.,5V				

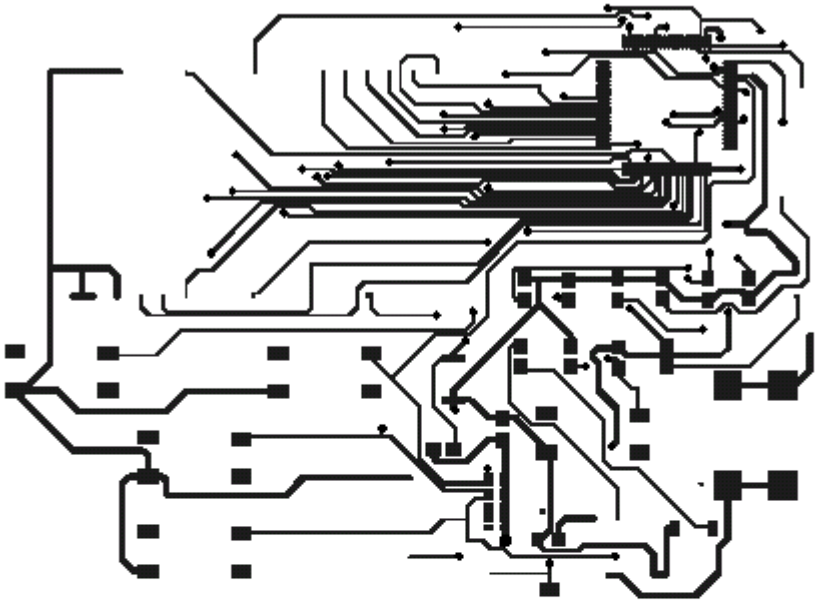
7.1 Schematic Diagram of MB89P568 Demo Board



7.2 MB89P568 Demo PCB Layout



7.3 PCB Top Layer



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